

Question #1

Choose the grading of diastolic function in 82 yo woman
 $E = 80 \text{ cm/s}$ $A = 70 \text{ cm/s}$ $LAVI < 34 \text{ mL/m}^2$

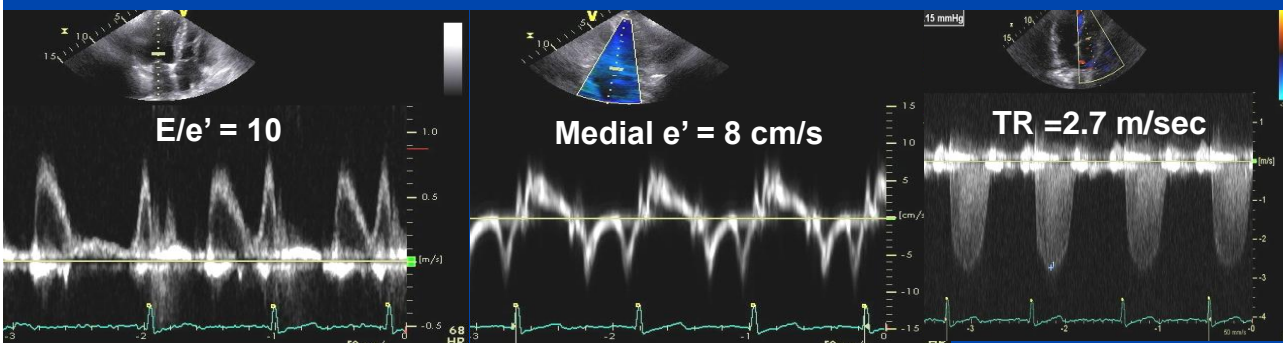


1= Grade 1 2= Grade 2 3= Grade 3 4= Normal 5= Indeterminate



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 $E = 80 \text{ cm/s}$ $A = 70 \text{ cm/s}$ $LAVI < 34 \text{ mL/m}^2$

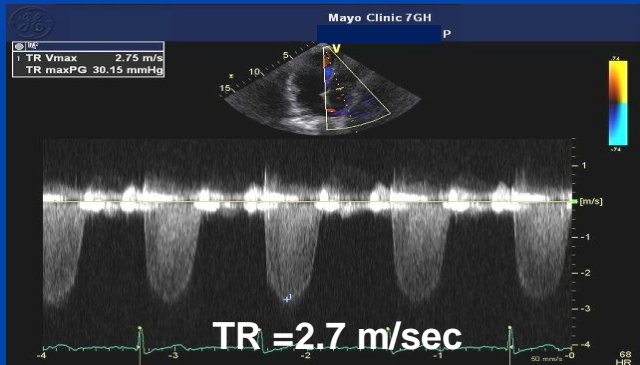
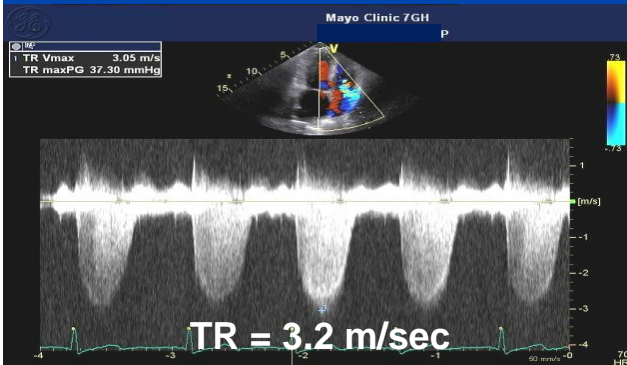


1= Grade 1 2= Grade 2 3= Grade 3 4= Normal 5= Indeterminate



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82 year old woman with normal diastolic function

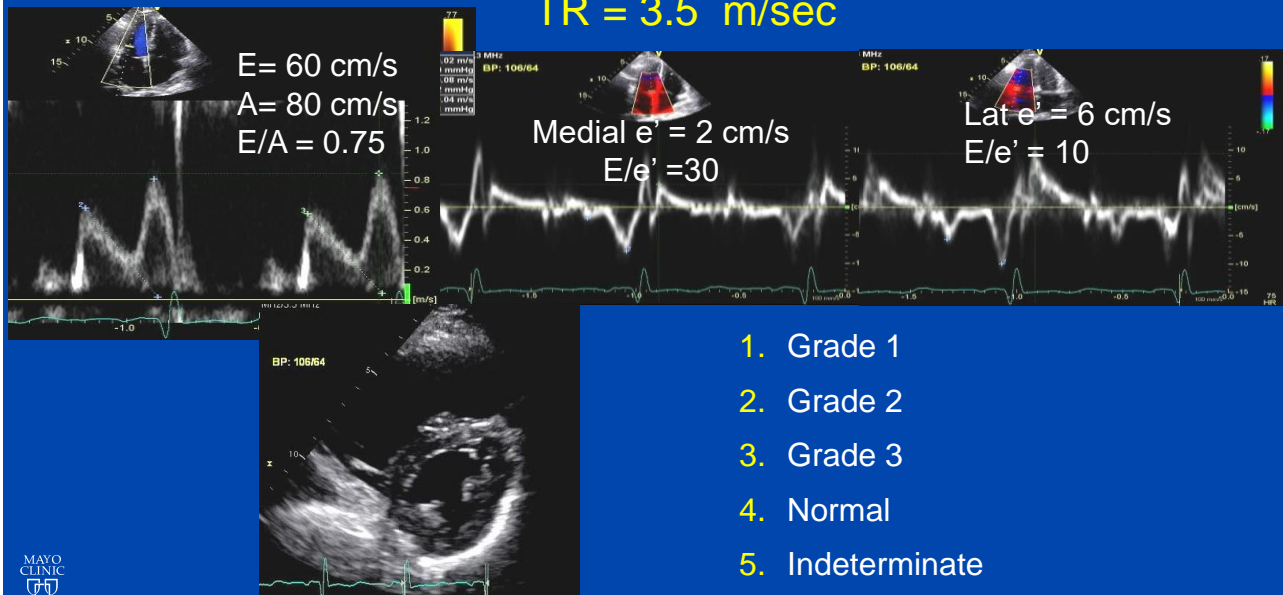


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Question #2

Grade diastolic function in 80 YO man with dyspnea

TR = 3.5 m/sec

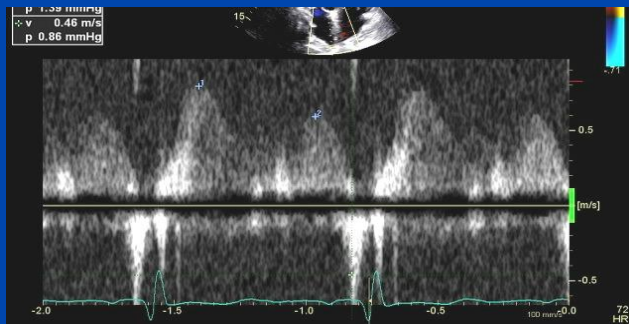


1. Grade 1
2. Grade 2
3. Grade 3
4. Normal
5. Indeterminate



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80 YO man with dyspnea Septal e' is reduced due to PHT



1. e' is reduced
2. E/e' +/-
3. LAVI normal
4. TR is high



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80 year old man with dyspnea and PHT Cardiac Cath Data

- RA pressure 2 mmHg
- RVSP 50 mmHg
- Mean PASP 28 mmHg
- PCWP 4 mmHg
- LVEDP 13 mmHg
- Cardiac Index 1.5 L/min/m²

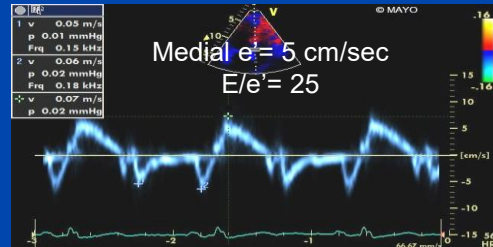
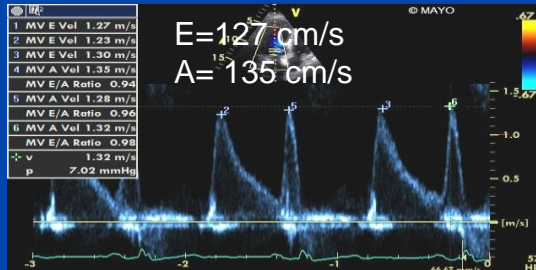


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Diastolic Function in 65 yo man with hypertension ?

Question #3

LAVI = 20 mL/m² & TR = 3 m/s

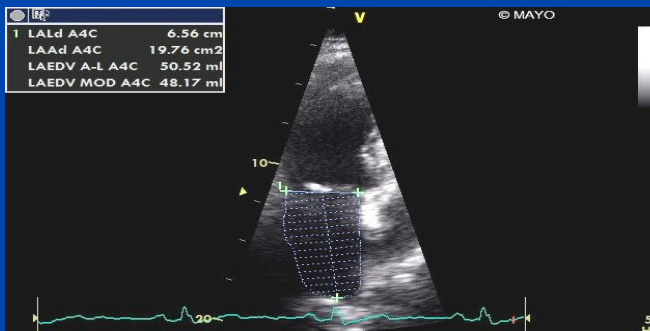


1. Grade 1
2. Grade 2
3. Grade 3
4. Normal Filling Pressure
5. Indeterminate



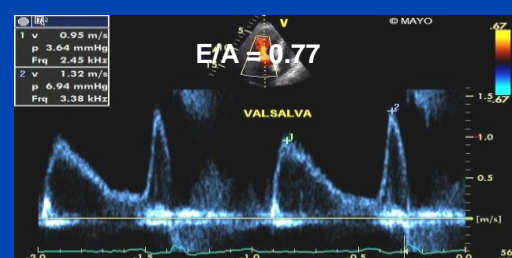
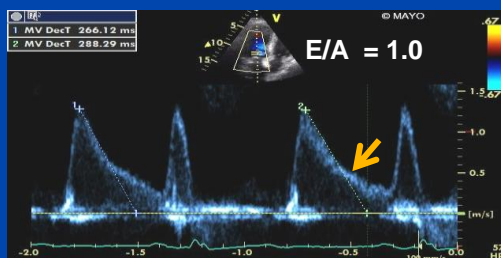
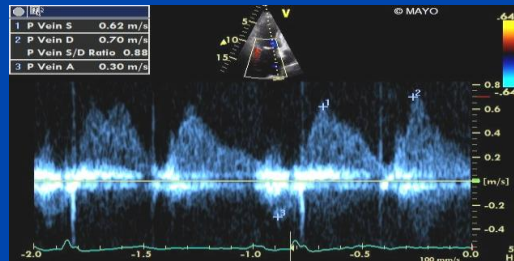
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LV volume measurement



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65 yo man with hypertension



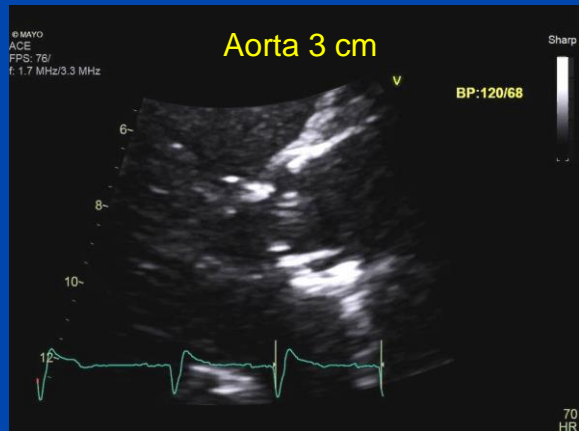
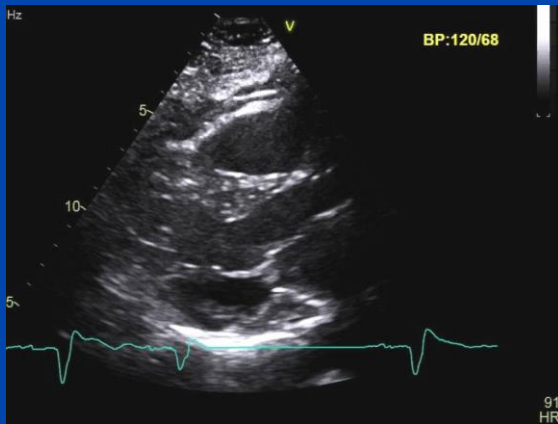
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Good Quality in Measurements is the Key!
No data is better than wrong data !



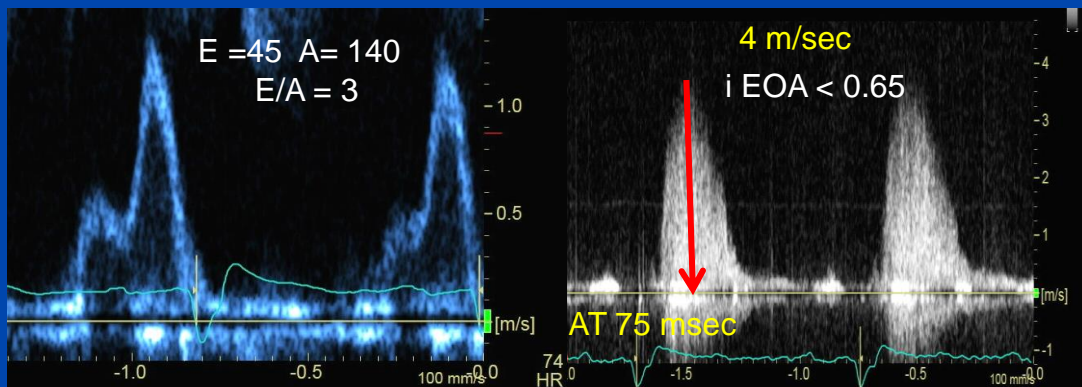
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78 yo woman with 21 mm CE AVR 2010 for severe AS
Referred for Valve in Valve with high gradient and dyspnea



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78 yo female with 21 mm CE AV prosthesis and SOB
How do you grade her diastolic function?

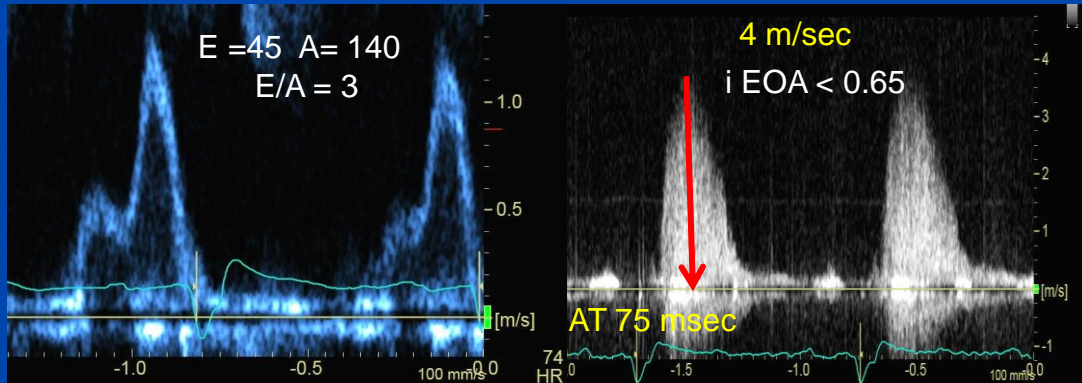


1. Grade 1
2. Grade 2
3. Grade 3
4. Normal Filling Pressure
5. Indeterminate



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78 yo female with 21 mm CE AV prosthesis and SOB
What is your next diagnostic step?

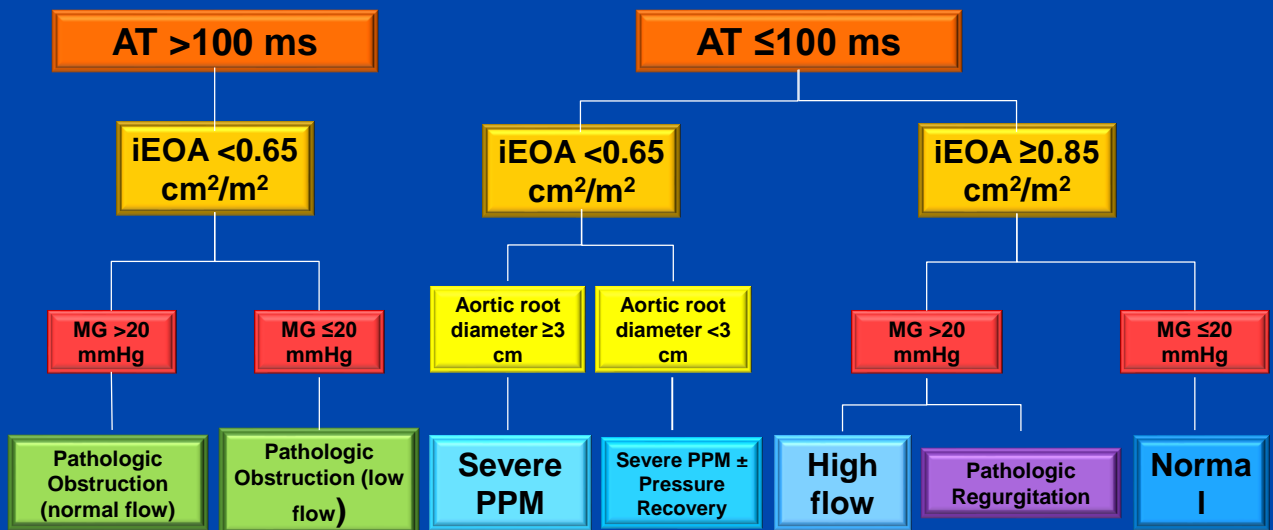


1. Aortic valve replacement
2. Refer to pulmonary
3. Exercise test
4. TEE
5. Old age and Observe



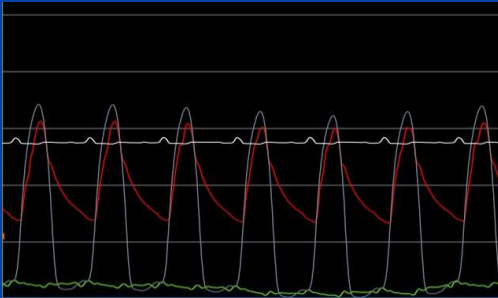
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Pericardial Aortic Prosthesis



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Exercise Cardiac Catheterization PPM + Pressure Recovery

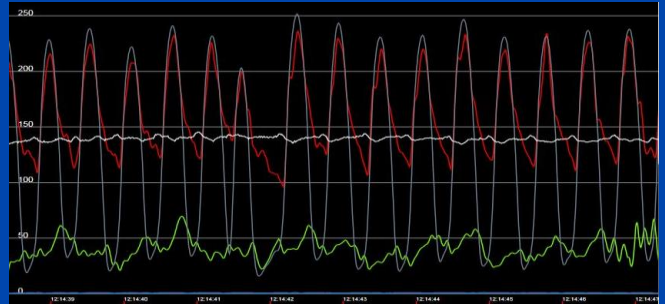


Rest

LVEDP 12, PAWP 8

CO 2.8, CI 1.5, MG 17 mmHg

AVA 1.1 cm²



Exercise

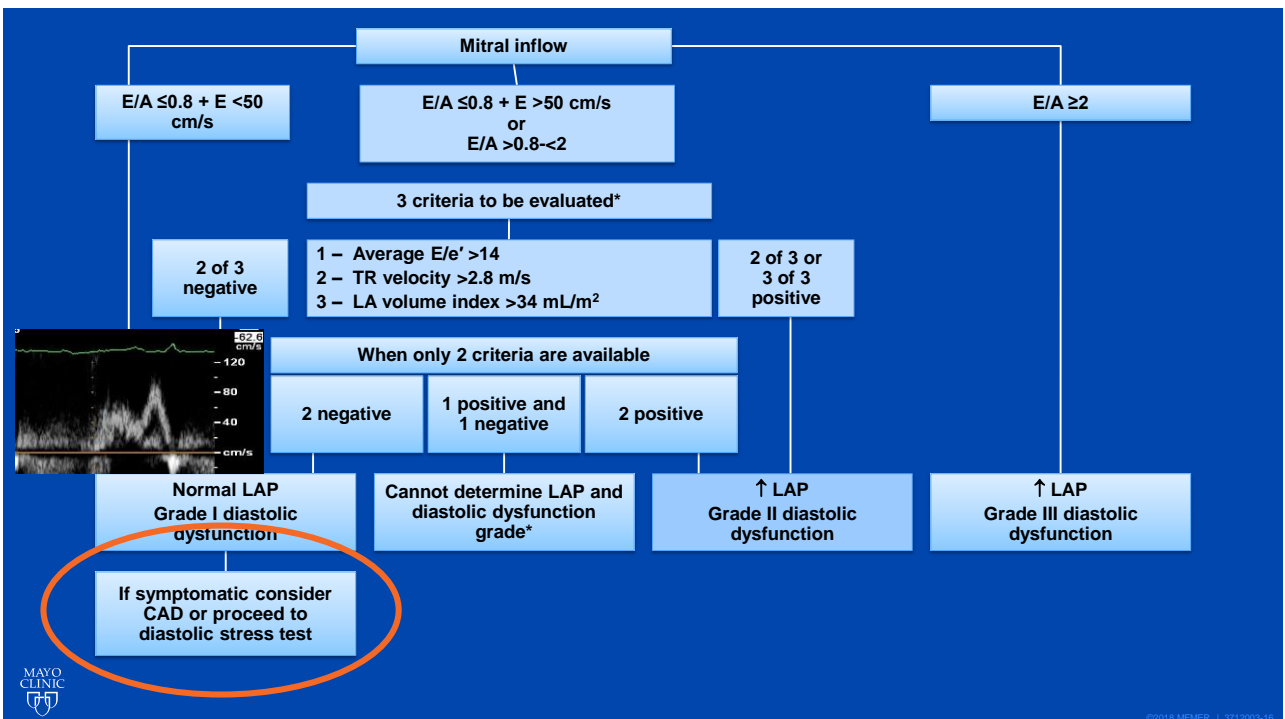
PAWP 41, LVEDP 44, mean PA 46

Aortic pressure 220

CO 5.7, CI 3.1, gradient 10, AVA 2.0 cm²

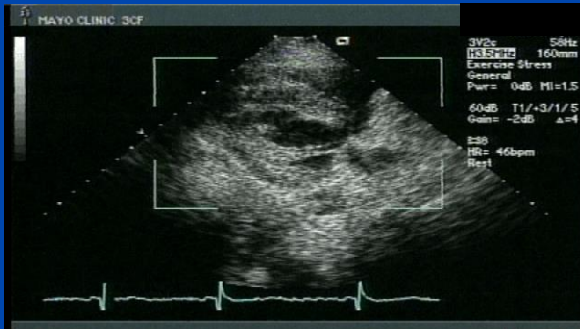


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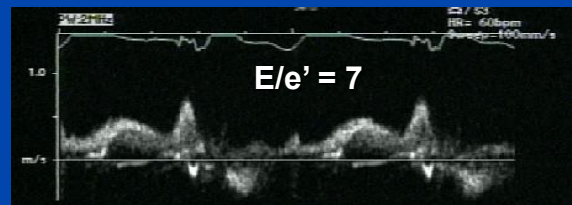


©2018 MFMR | 3712003-16

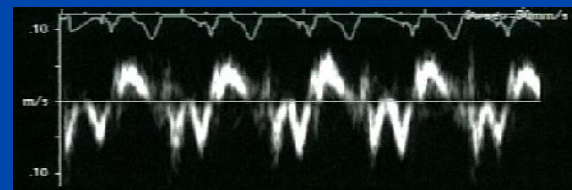
73 yo woman with Hypertension and Exertional Dyspnea No ischemia



“This patient has delayed myocardial relaxation, but filling pressure is not increased at rest”



E = 50 cm/s DT = 250 ms

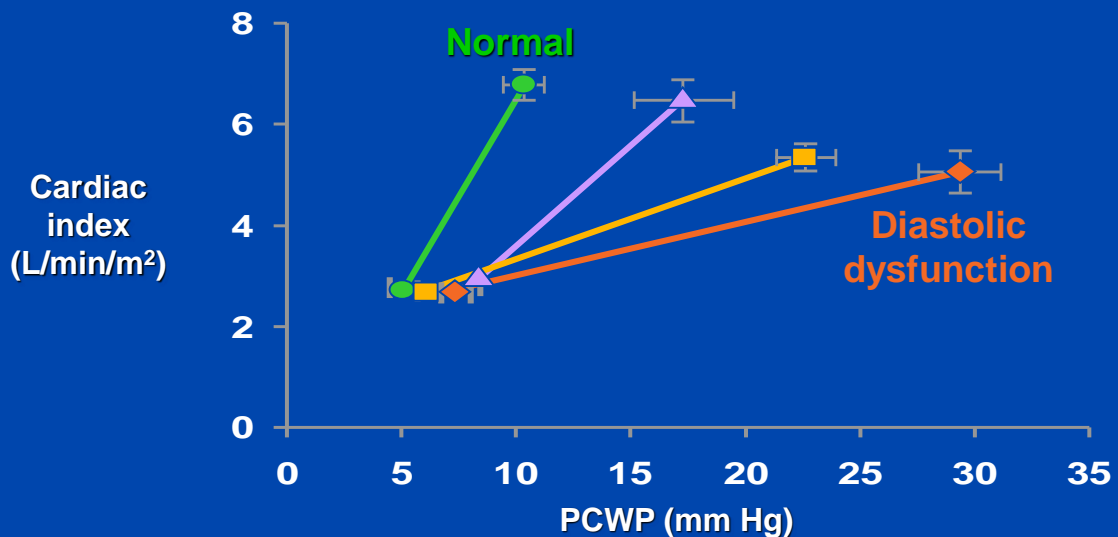


e' = 7 cm/s



CP1082496-61/8/2018
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Change in CI and PCWP with Exercise Normal and Abnormal Diastolic Function



CP1082496-59/8/2018
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Dynamic Diastology

Filling Pressure (E/e') with Exercise

	E	e'	E/e'
Normal	↑	↑	↔
Abnormal	↑	↔	↑

LV filling pressure (E/e') does not increase much with exercise in normal heart, but increases in symptomatic patients with diastolic dysfunction.



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Diastolic Stress Test

Baseline and Peak (or Post) Exercise

- Supine bike or Treadmill
- 25 watts (3 min) increments
- Assess LVEF, size, and wall motion
- Mitral inflow (E, A, and DT)
- Mitral annulus velocity
- E/e' ratio
- TR velocity



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Effects of Treadmill Exercise on Mitral Inflow and Annular Velocities in Healthy Adults

Jong-Won Ha, MD, PhD, Fabijan Lulic, MD, Kent R. Bailey, PhD, Patricia A. Pellikka, MD, James B. Seward, MD, A. Jamil Tajik, MD, and Jae K. Oh, MD

	Baseline	Exercise
E (cm/s)	73±19	90±25
A (cm/s)	69±17	87±22
DT (ms)	192±40	176±42
e' (cm/s)	12±4	15±5
E/e'	6.7±2.2	6.6±2.5

Mean age 59±14 yrs

Ha J et al: *AJC*, 2003

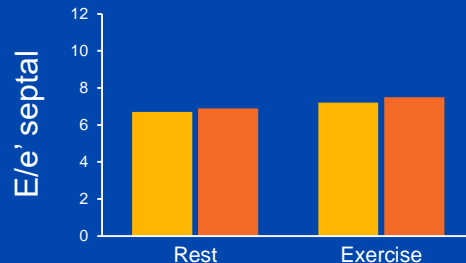
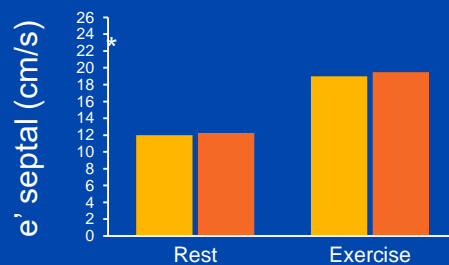
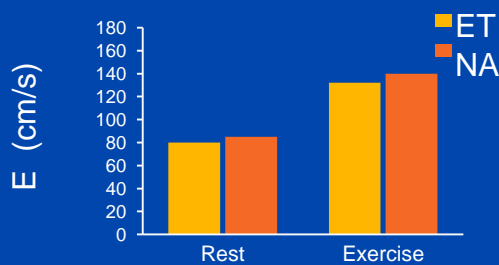


CP12540 5/8/2018
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LV Diastolic Function at Rest and With Stress

Diastolic Stress Echocardiography in the Young:
Endurance-Trained (ET) Healthy Subjects

Nonathletic (NA) and



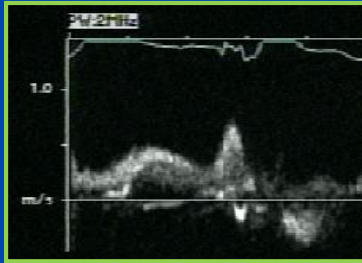
Mean age 29 yrs



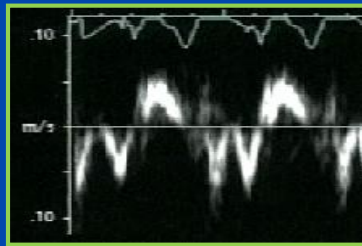
Bruengger et al: *JASE*, 2014

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Exertional Dyspnea

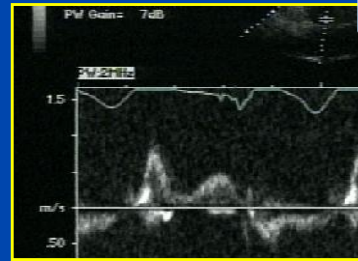


$E = 50$
 $DT = 250$

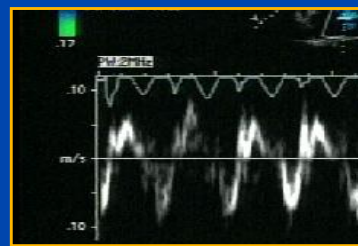


$e' = 7$
 $E/e' = 7$
 $TR = 2.4$

Baseline



$E = 85$
 $DT = 140$



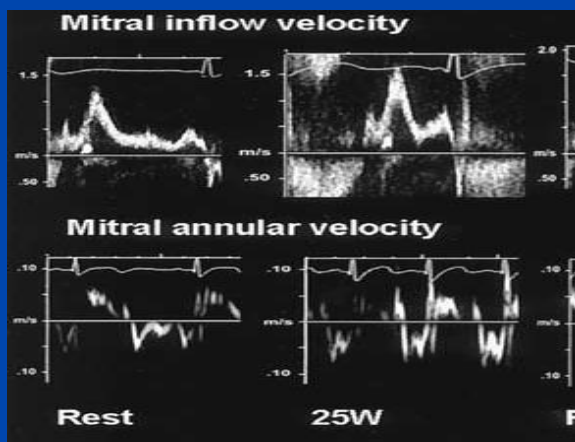
$e' = 7$
 $E/e' = 12$
 $TR = 3.8$

Supine Bike



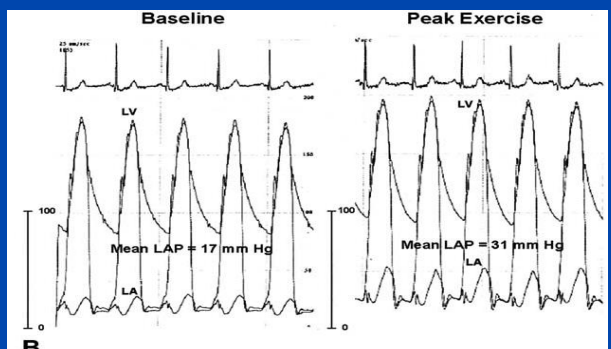
CP1082496-618/2018
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Echo-Cath Correlation



$E/e' = 16$

$E/e' = 25$

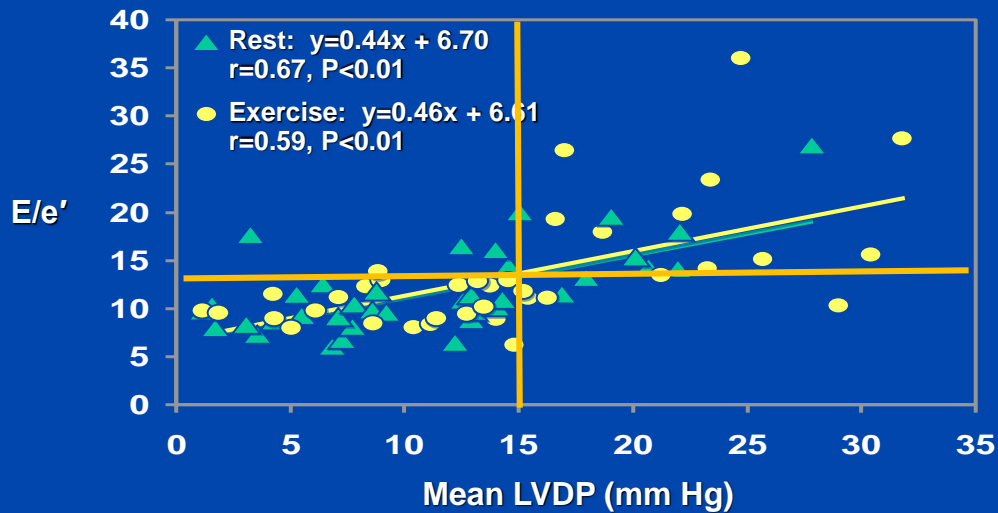


Ha et al. JASE 2005



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Mean LVDP vs E/e' Rest and Exercise



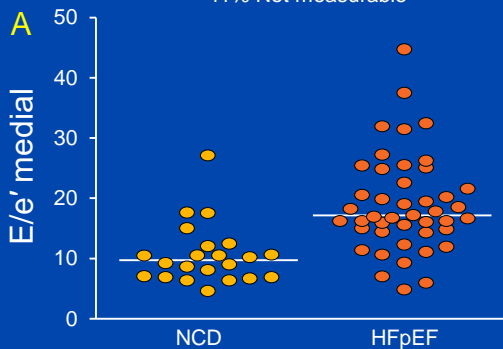
Burgess et al: JACC 47:1891, 2006

CP12540 5/8/2018
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Echocardiographic Hemodynamic and Ventricular Function Indices During Exercise

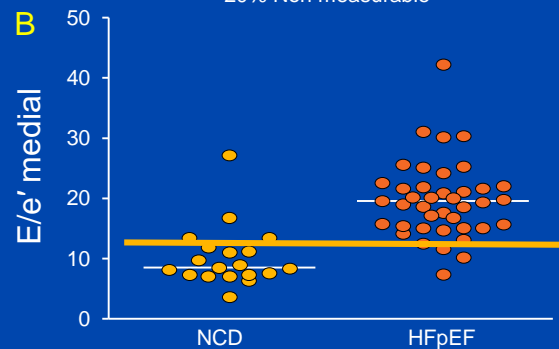
Submaximal (20W)

$P<0.0001$
 11% Not measurable



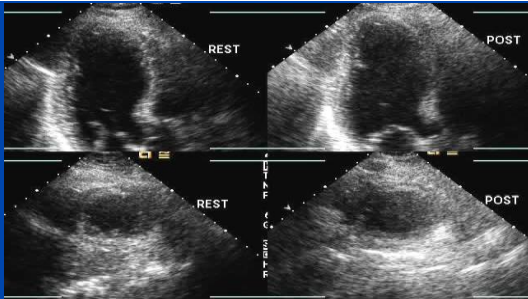
Peak

$P<0.0001$
 20% Non measurable

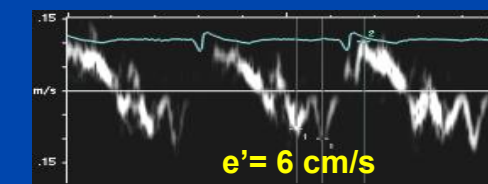
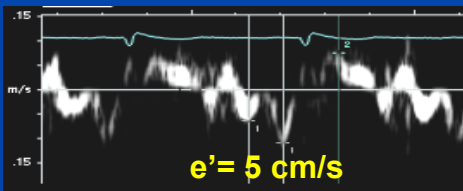
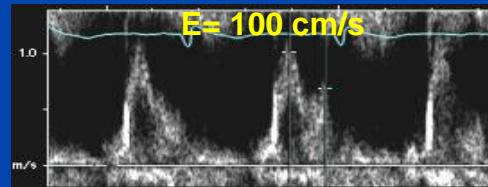
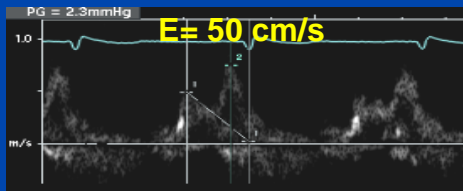


Obokata M et al: Circ 135:825-838, 2017

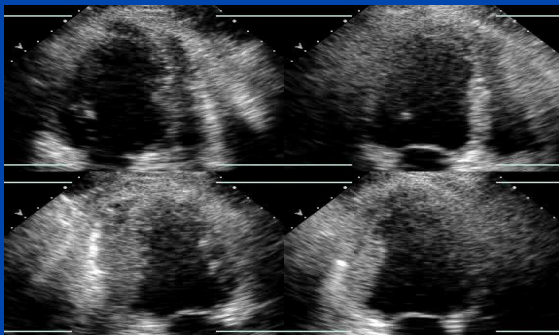
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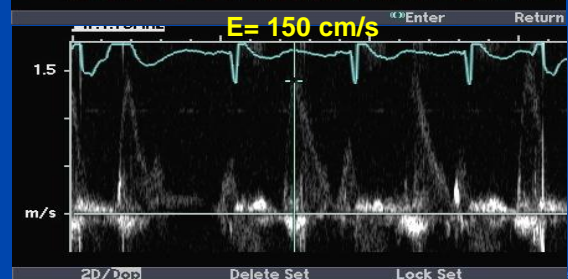
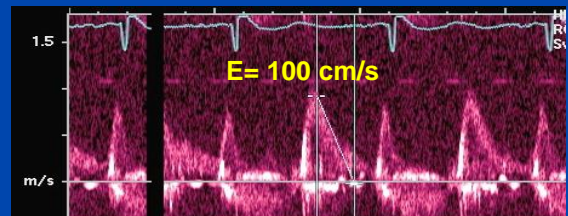
Exercise Echo for Dyspnea



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Exercise Echo for Dyspnea



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Which of following clinical situation is best suited for using E/A ratio as the initial diastolic assessment parameter?

Question #4

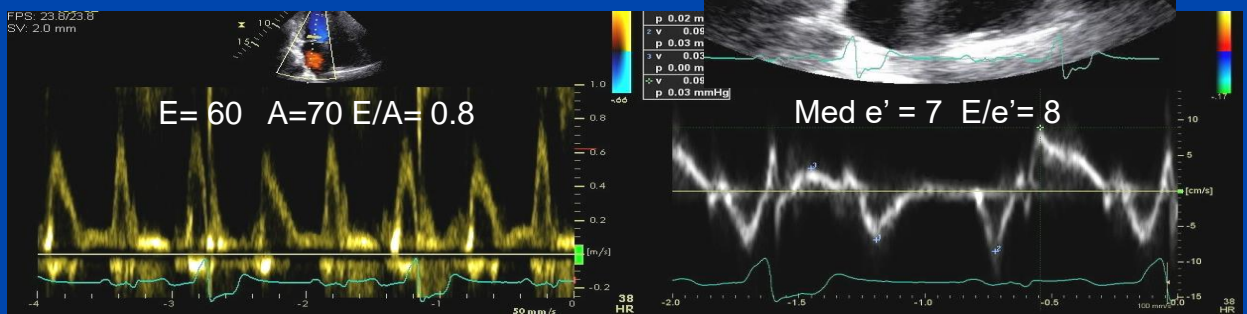
1. Age > 80 years
2. Uncontrolled hypertension
3. LVEF 45%
4. AL Cardiac Amyloidosis
5. Hypertrophic cardiomyopathy
6. Marked mitral annulus calcification



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Question #5

79 year old with bigemini

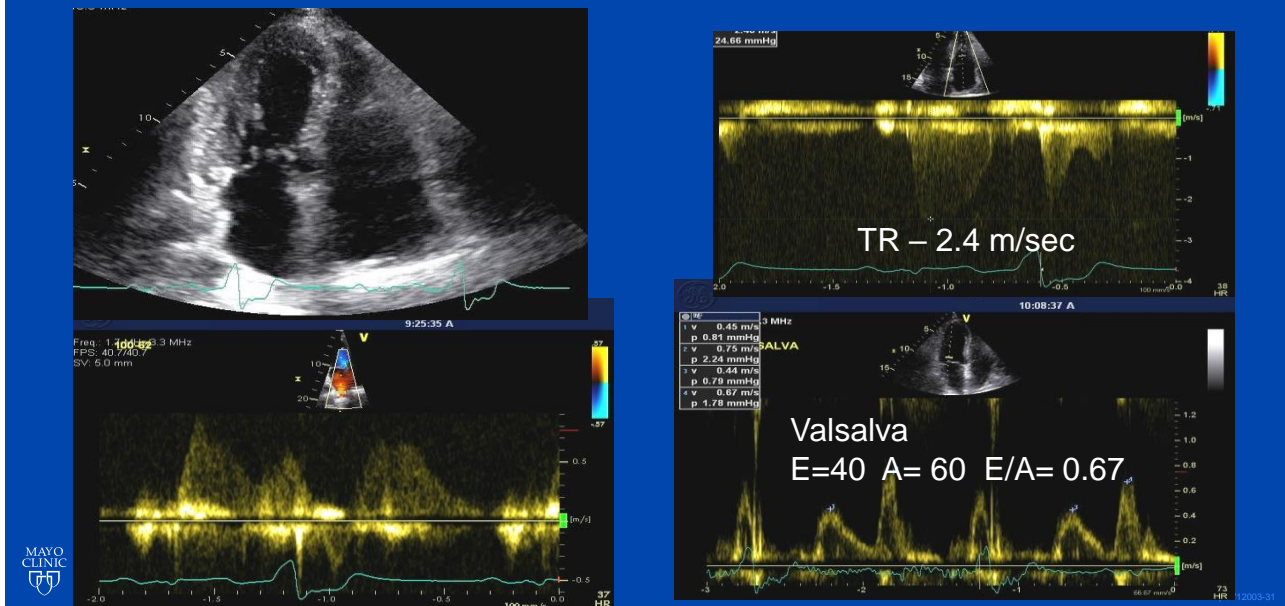
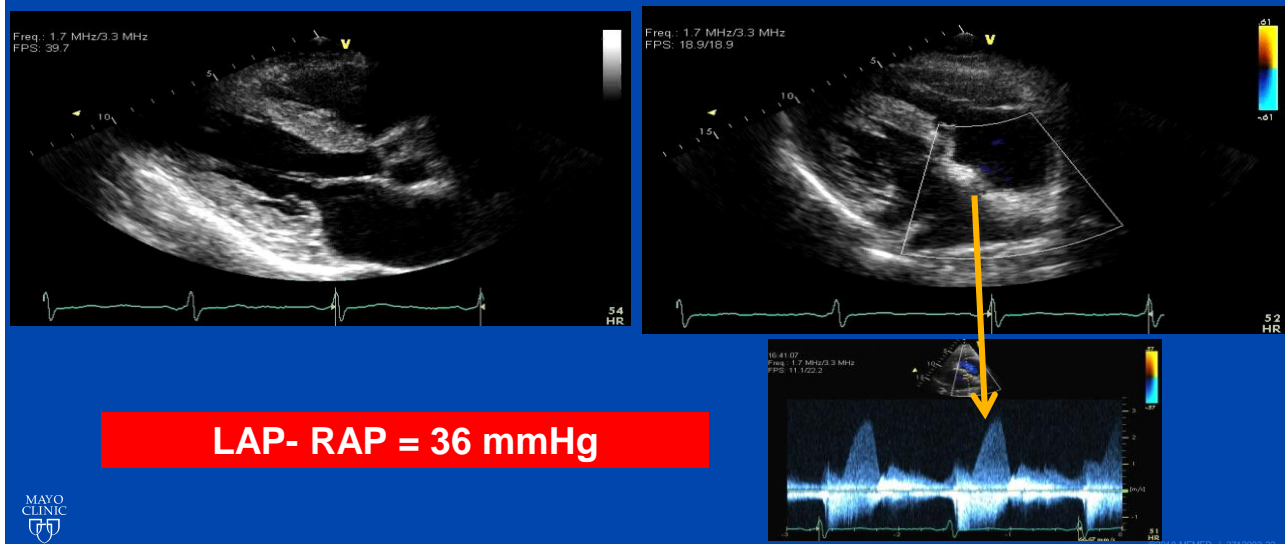


1. Grade 1
2. Grade 2
3. Grade 3
4. Normal Filling Pressure
5. Indeterminate

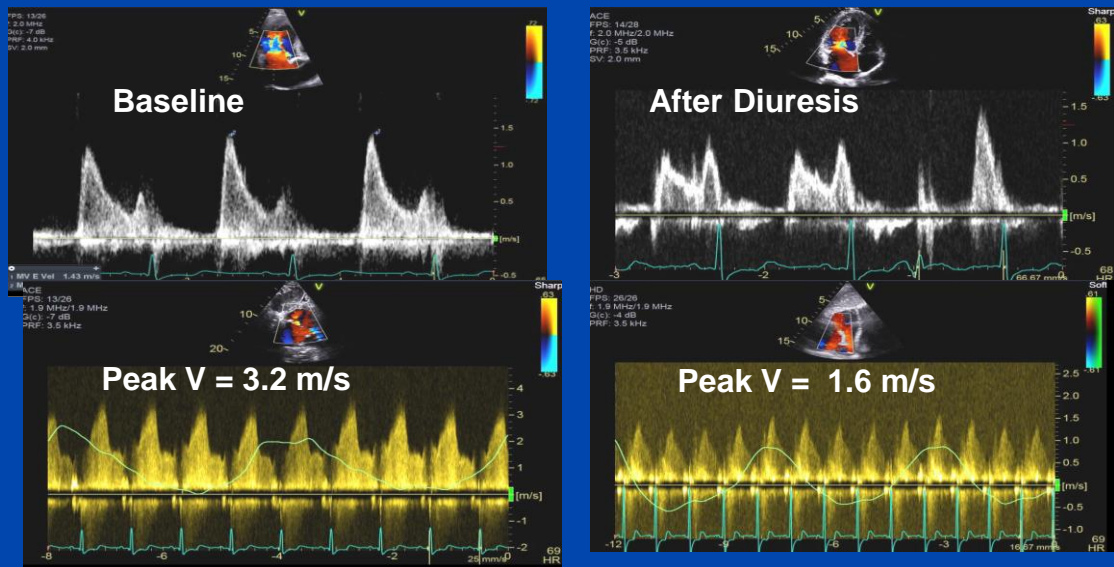


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79 yo with bigemini

69 year old man with dyspnea
PFO velocity

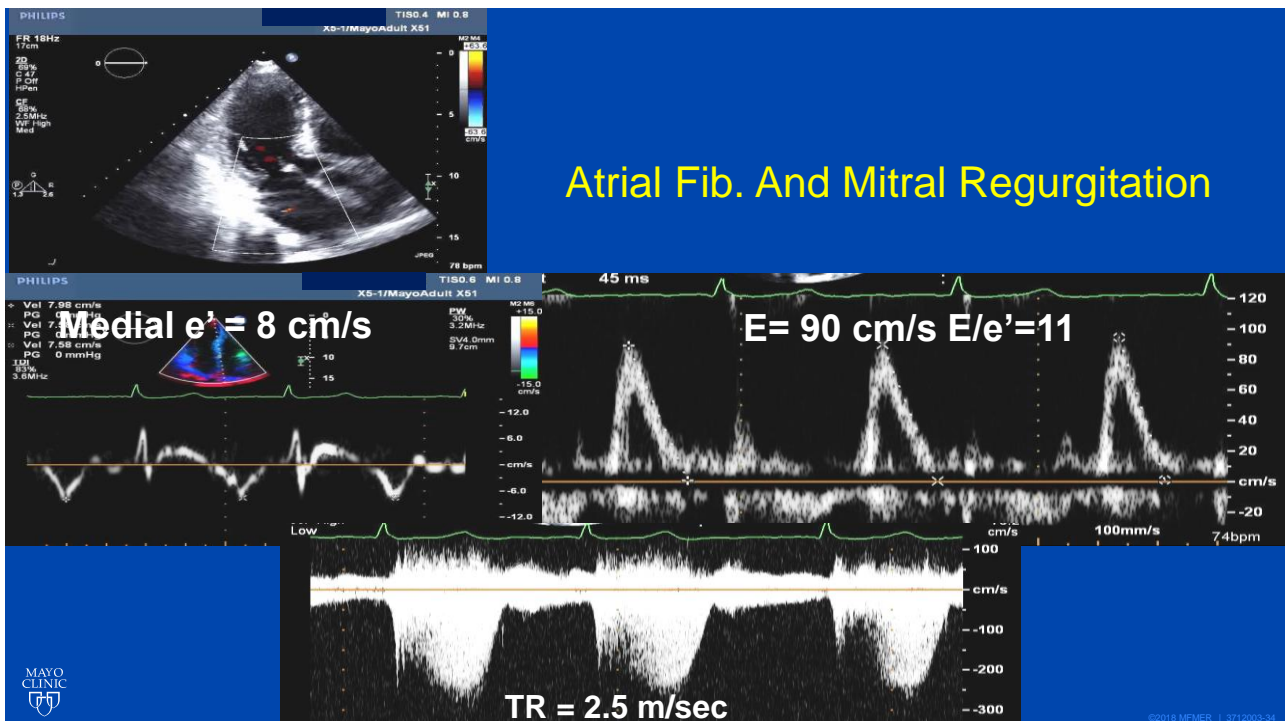
PFO Velocity for estimating LA pressure



From Chandra, MD & Will Miranda, MD

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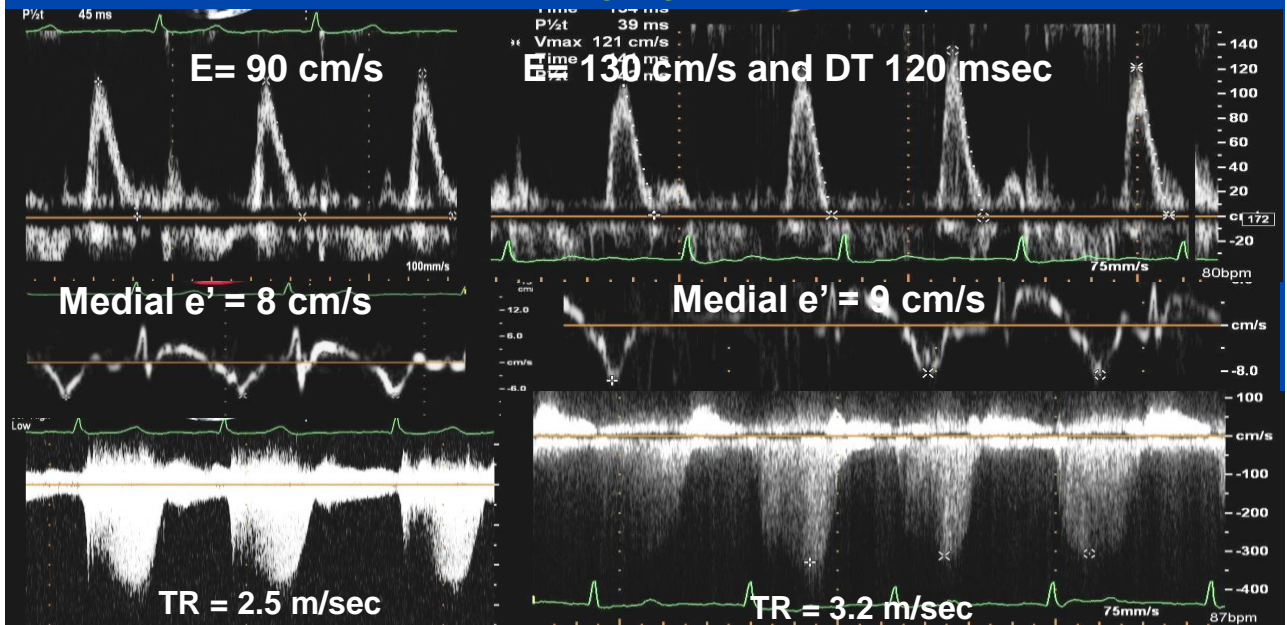
Atrial Fib. And Mitral Regurgitation



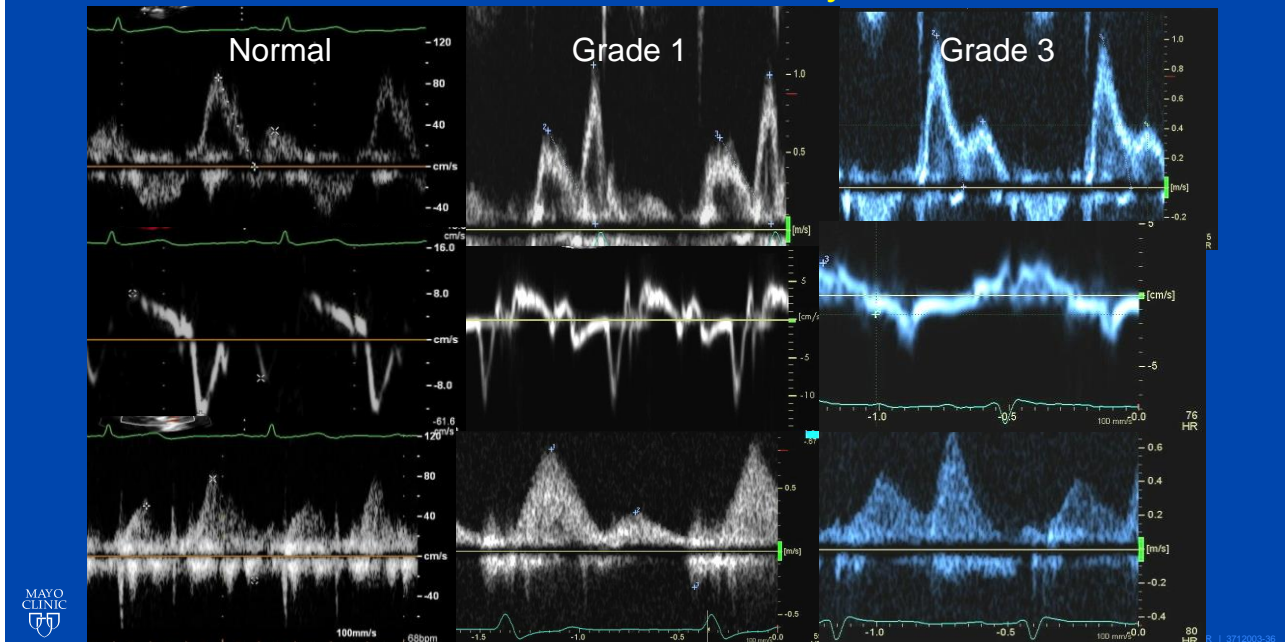
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Atrial Fib. And Mitral Regurgitation

with exercise



Mitral E, e' and Pulmonary Vein





Questions & Discussion

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Pericardial Diseases Questions



Jae K. Oh, MD

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Question #6

Who from following patients has the highest medial e' velocity expected?

1. 35 year old woman with CP after radiation treatment
2. 65 year old woman with CP after viral illness
3. 55 year old man with CP after CABG
4. 45 year old man with cardiac Fabry's
5. 75 year old woman with HFPEF

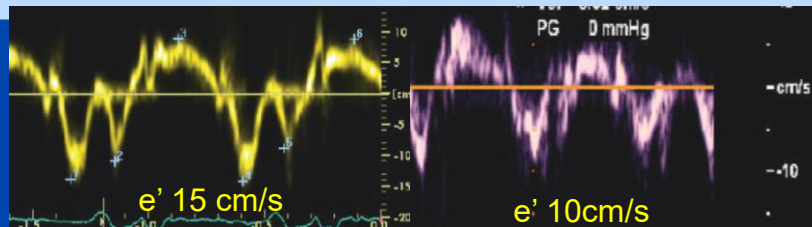


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Mitral and Tricuspid Annular Velocities Before and After Pericardiectomy in Patients With Constrictive Pericarditis

Gabriella Veress, MD; Lieng H. Ling, MD; Kye-Hun Kim, MD, PhD; Jacob P. Dal-Bianco, MD; Hartzell V. Schaff, MD; Raul E. Espinosa, MD; Rowlens M. Melduni, MD; Jamil A. Tajik, MD; Thoralf M. Sundt, III, MD; Jae K. Oh, MD

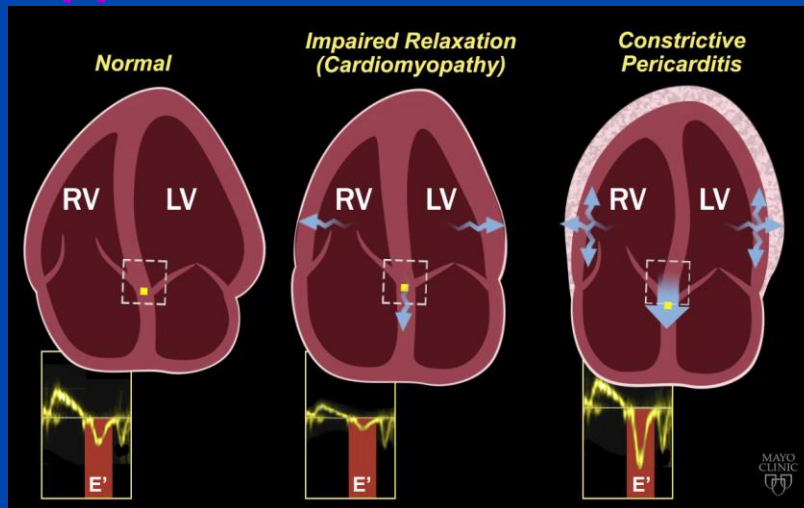
	Primary CP	Secondary CP	Primary CP	Secondary CP
	Baseline		Post Pericardiectomy	
Medial e'	14.6 ± 3.4	10.3 ± 3.5	9.0 ± 2.9	7.0 ± 2.0
Lateral e'	12.8 ± 3.8	10.3 ± 2.8	10.0 ± 3.0	7.6 ± 2.0



Veress et al. Circulation CV Imaging July 2011

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Tissue Doppler in Constriction vs Restriction



E' normal to high in constriction, low in myocardial disease

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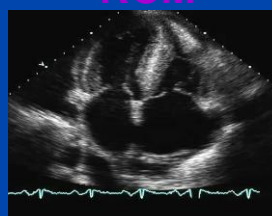
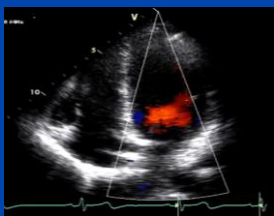
Normal vs RCM vs CP

Medial Mitral e' velocity (LV Relaxation)

Normal

RCM

CP



Medial e' 13 cm/s

Medial e' 3 cm/s

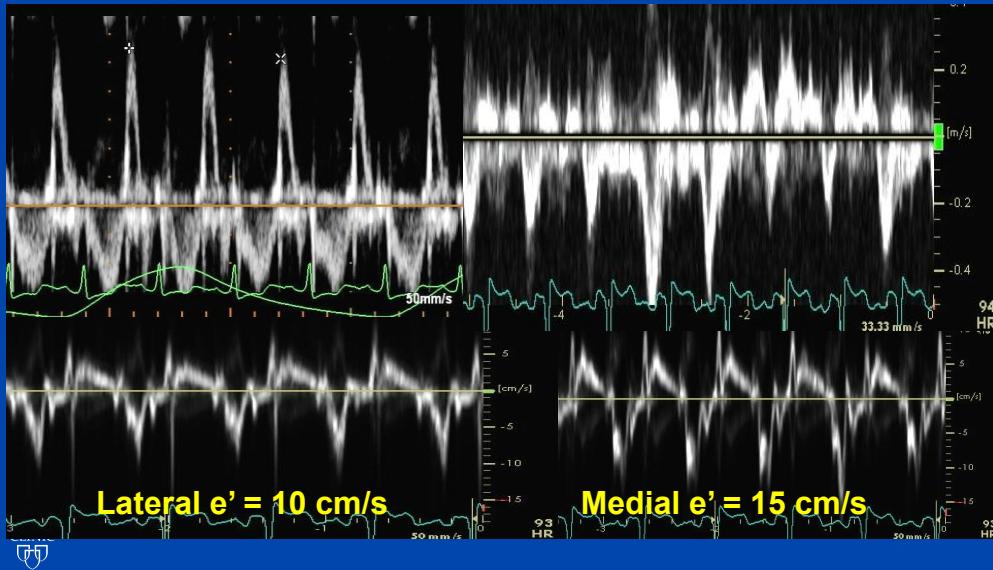
Medial e' 14 cm/s
Usually > Lateral e'
(Annulus Reversus)



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Question
#7

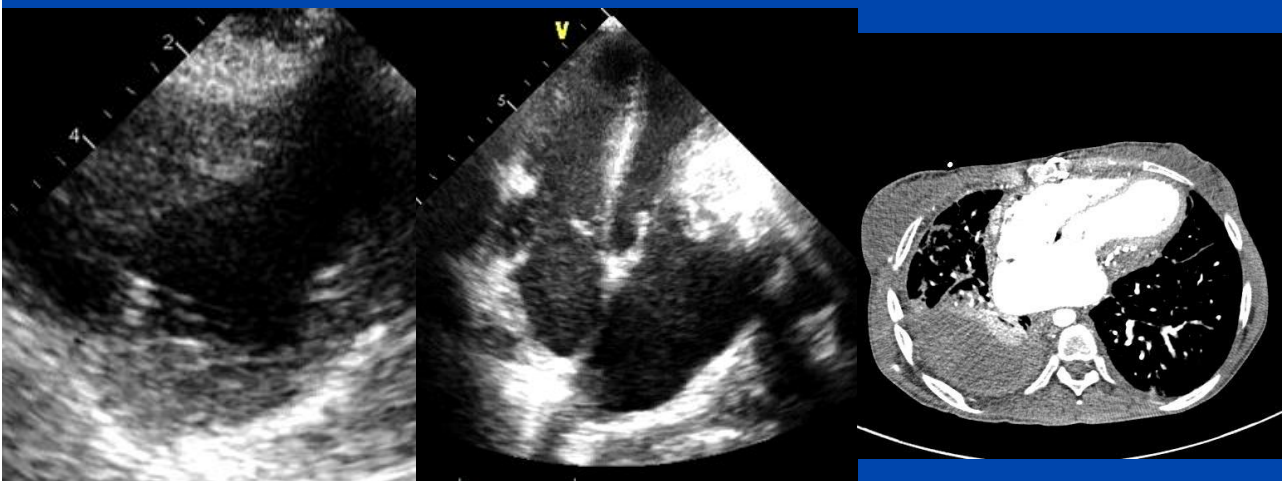
**A 26 year old woman with a previous pericardiectomy, for tbc CP presenting with edema
Doppler demonstrates ?**



1. Recurrent CP
2. Normal
3. Restriction
4. Respiratory distress

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A 26 year old woman with a previous pericardiectomy, presenting with edema

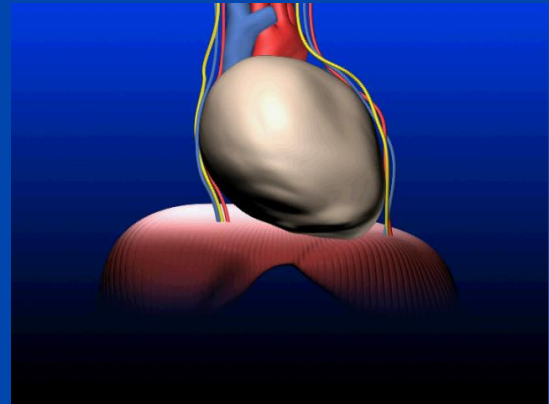
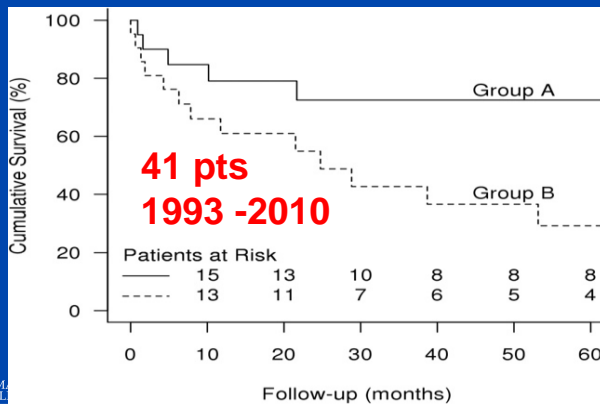


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Completion Pericardiectomy for Recurrent Constrictive Pericarditis: Importance of Timing of Recurrence on Late Clinical Outcome of Operation

Yang Hyun Cho, MD, Hartzell V. Schaff, MD, Joseph A. Dearani, MD, Richard C. Daly, MD, Soon J. Park, MD, Zhuo Li, MS, and Jae K. Oh, MD

Division of Cardiovascular Surgery, Division of Biomedical Statistics and Informatics, and Division of Cardiovascular Disease, Mayo Clinic, Rochester, Minnesota

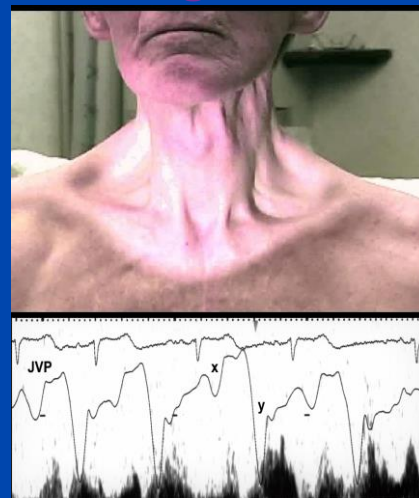


Cho and Schaff et al. Ann Thorac Surg 2012

Which of following statements is correct regarding Kussmaul sign ?

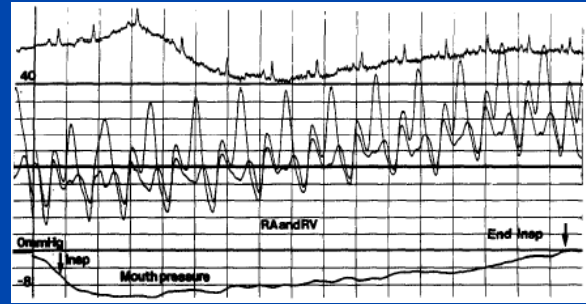
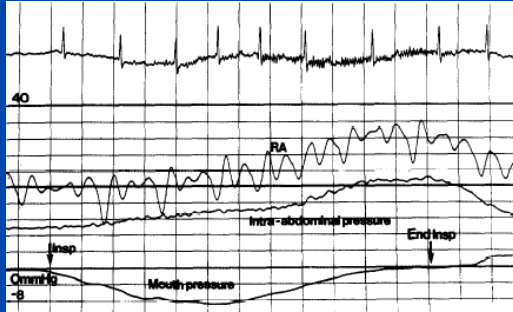
Question #8

1. Expiratory increase in JVP
2. Cannot be correct since opposite to Hepatic Vein
3. Due to increased IVC flow



Mechanism Underlying Kussmaul's Sign in Chronic Constrictive Pericarditis

Theo E. Meyer, MB, FCP (SA), Pinhas Sareli, MD, Richard H. Marcus, MB, FCP (SA), Wendy Pocock, MB, FRCP, Martin R. Berk, MB, FCP (SA), and Maurice McGregor, MD



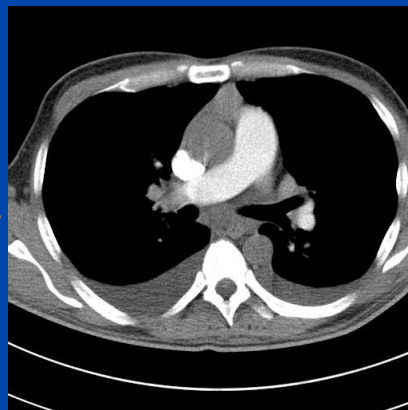
T Meyer AJC 1989

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Question #9

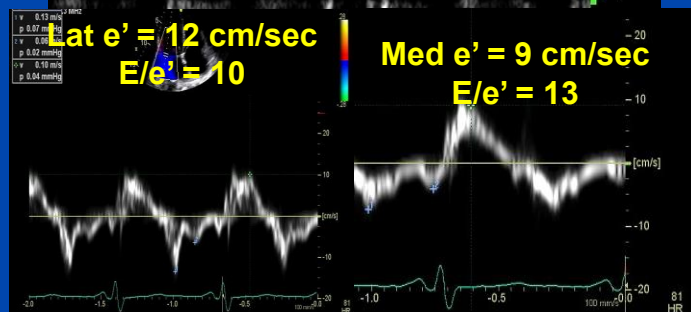
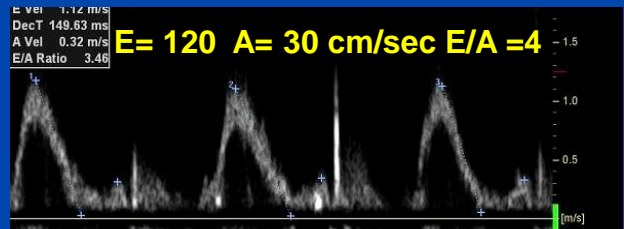
42 year old man with dyspnea

- Gradual onset of chest tightness and dyspnea
- Physical Examination
 - HR 90 BPM
 - JVP mildly elevated
 - Increased S2 intensity
 - GR 1/6 systolic murmur
 - Mild pitting edema



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42 year old man with dyspnea What is his diastolic function?

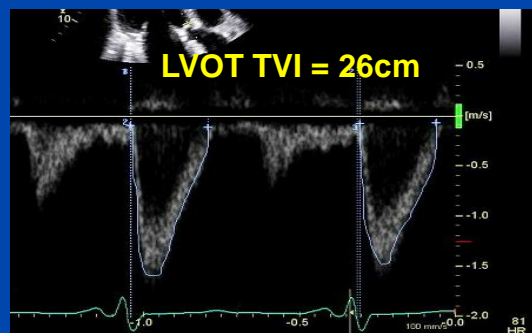
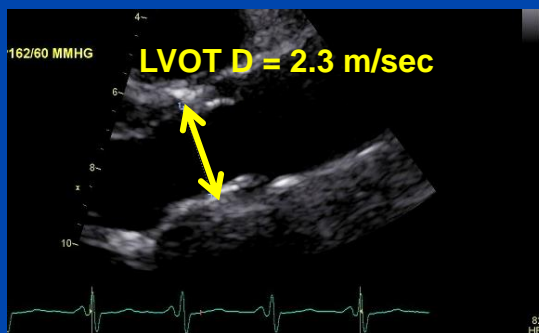


1= Grade 1 2= Grade 2
3= Grade 3 4= Normal
5= Constriction



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42 year old man with dyspnea and high output



$$SV = (2.3)^2 \times 0.785 \times 26 = 108 \text{ mL}$$

$$CO = SV \times HR = 108 \times 80 = 8.6 \text{ L}$$

$$CI = CO/BSA = 8.6 / 1.93 = 4.48 \text{ L/m}^2$$



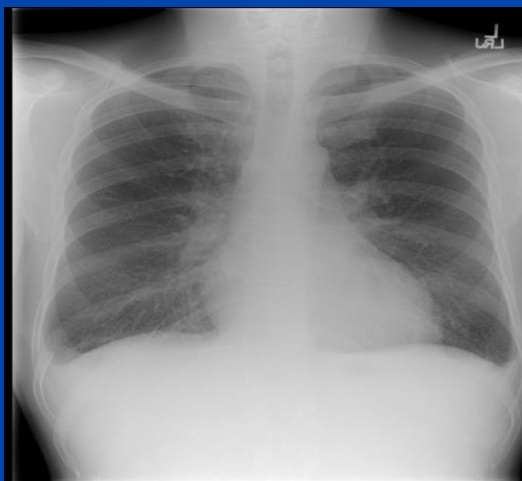
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What is the most common cause of HF seen in this 42 year old man?

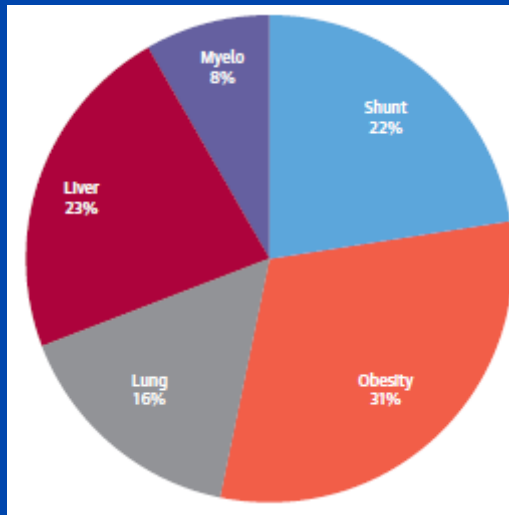
$$\begin{aligned} \text{SV} &= (2.3)^2 \times 0.785 \times 26 = 108 \text{ mL} \\ \text{CO} &= \text{SV} \times \text{HR} = 108 \times 80 = 8.6 \text{ L} \\ \text{CI} &= \text{CO}/\text{BSA} = 8.6 / 1.93 = 4.48 \text{ L/m}^2 \end{aligned}$$

1. Shunt
2. Obesity
3. Liver Disease
4. Pheochromocytoma

42 year old man with high output HF Before and after treatment (Thyrotoxicosis)



Etiologies of High Output Failure Cardiac Index $> 4.0 \text{ L/m}^2$

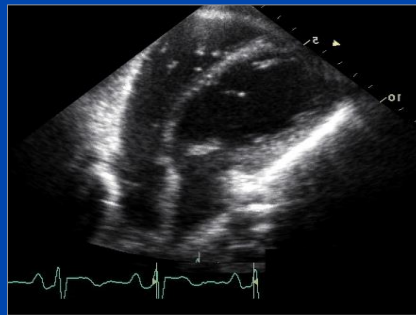


- Obesity (31%)
- Liver Disease (23%)
- Shunt (22%)
- Diastolic function can be normal

Reddy et al JACC 2017

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47 year old man with chest pain
What is your next step?

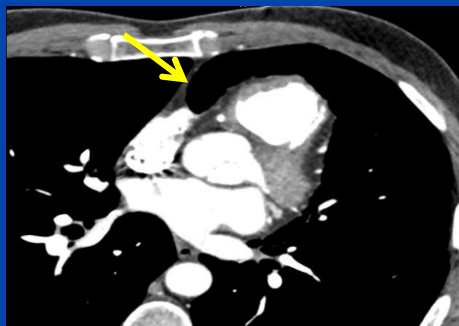
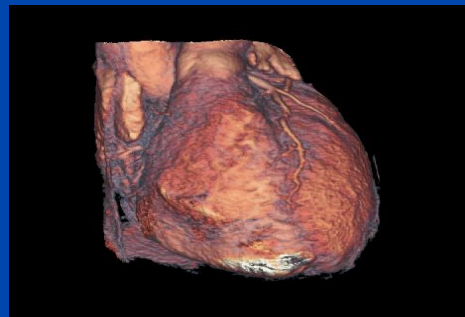


Question #10



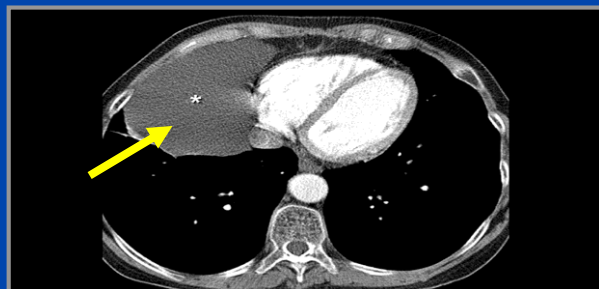
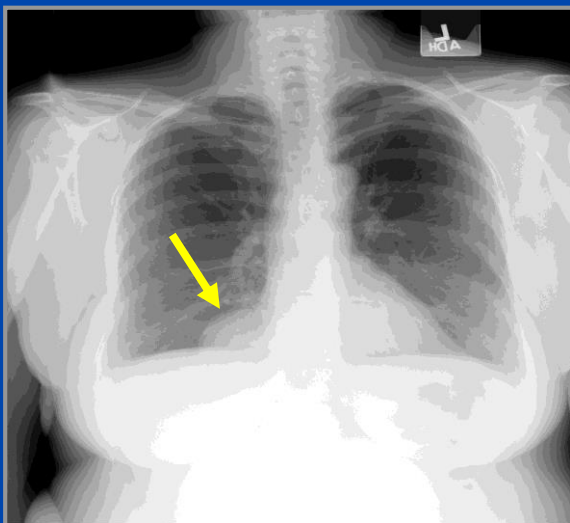
1. Cardiac Cath
2. TEE
3. CT
4. Stress Echo

Congenital Absence of the Pericardium



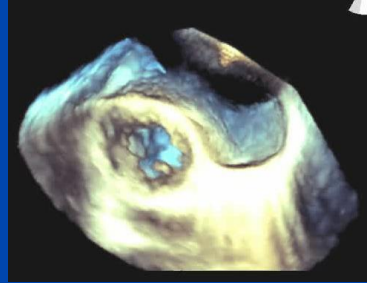
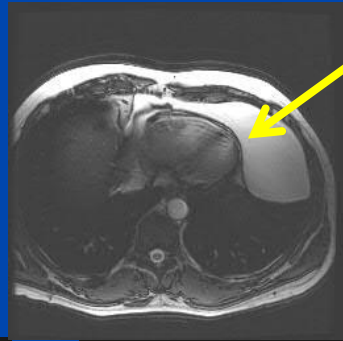
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Pericardial Cyst



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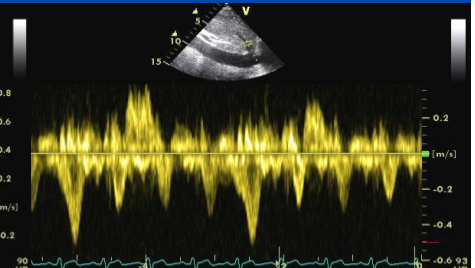
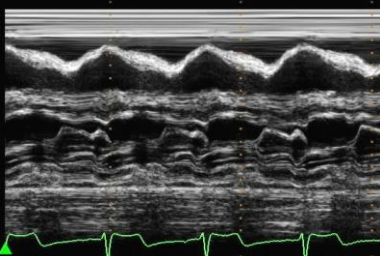
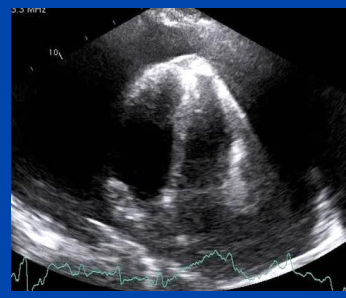
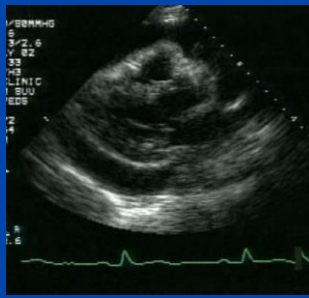
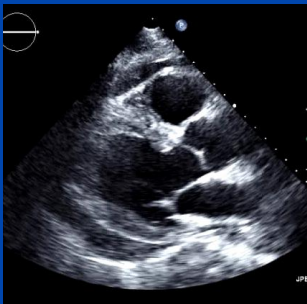
A large pericardial cyst



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Cardiac Tamponade



RV collapse

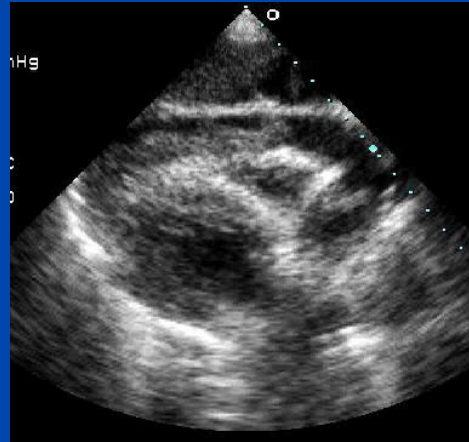
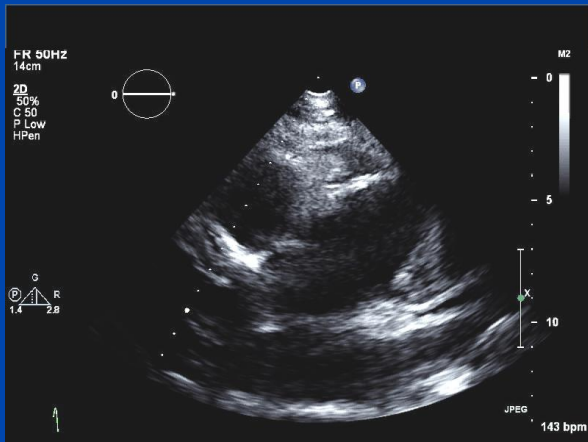
Mitral inflow variation

HV expiratory reversal

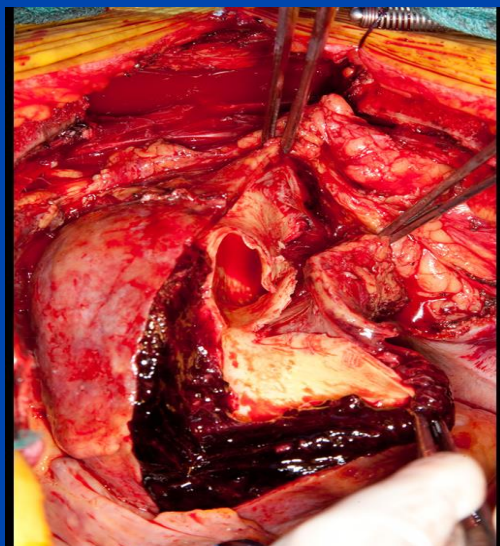
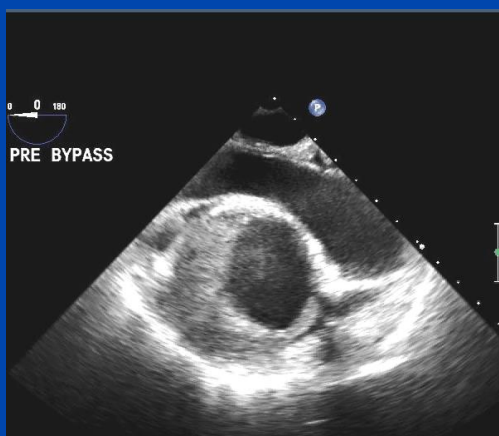
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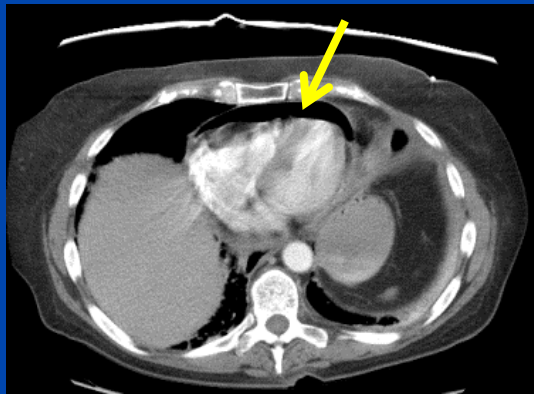
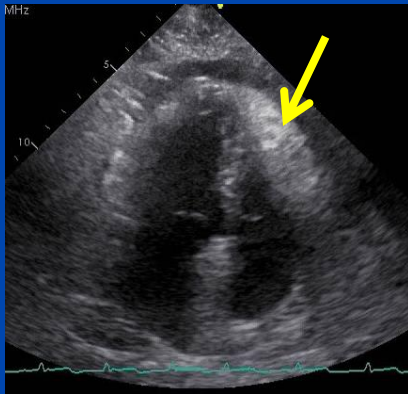
Hemo-pericardium



Intramural Hematoma



66 year old woman with dyspnea Pneumo-pericardium

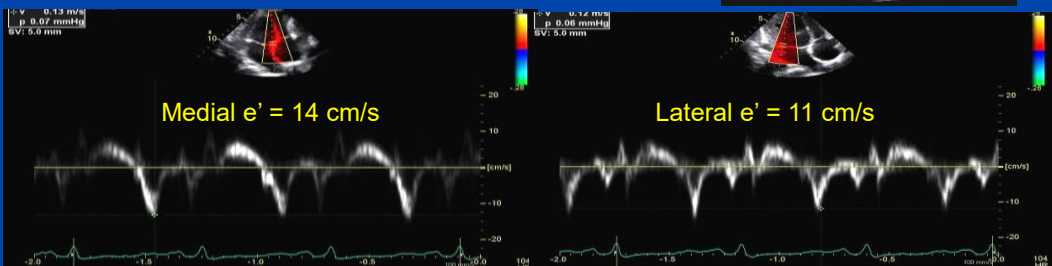
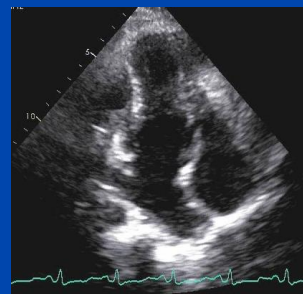
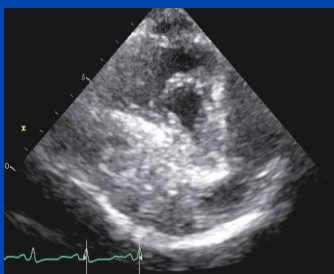


PneGastro-pericardial fistula



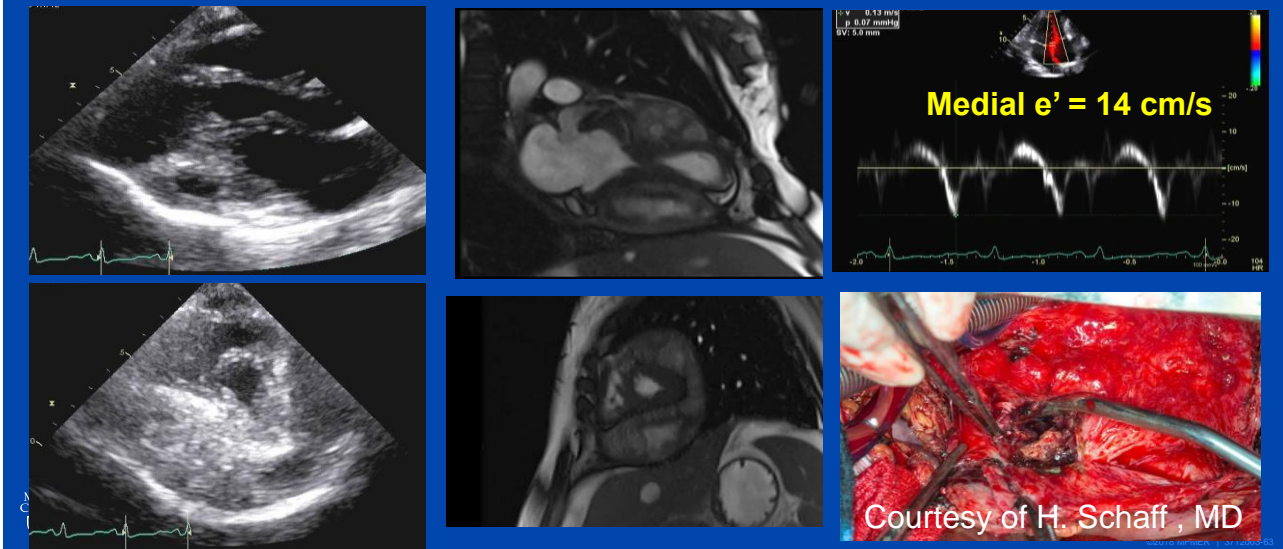
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23 year old woman from Middle East with ascites several month after acute pericarditis and pericardial effusion

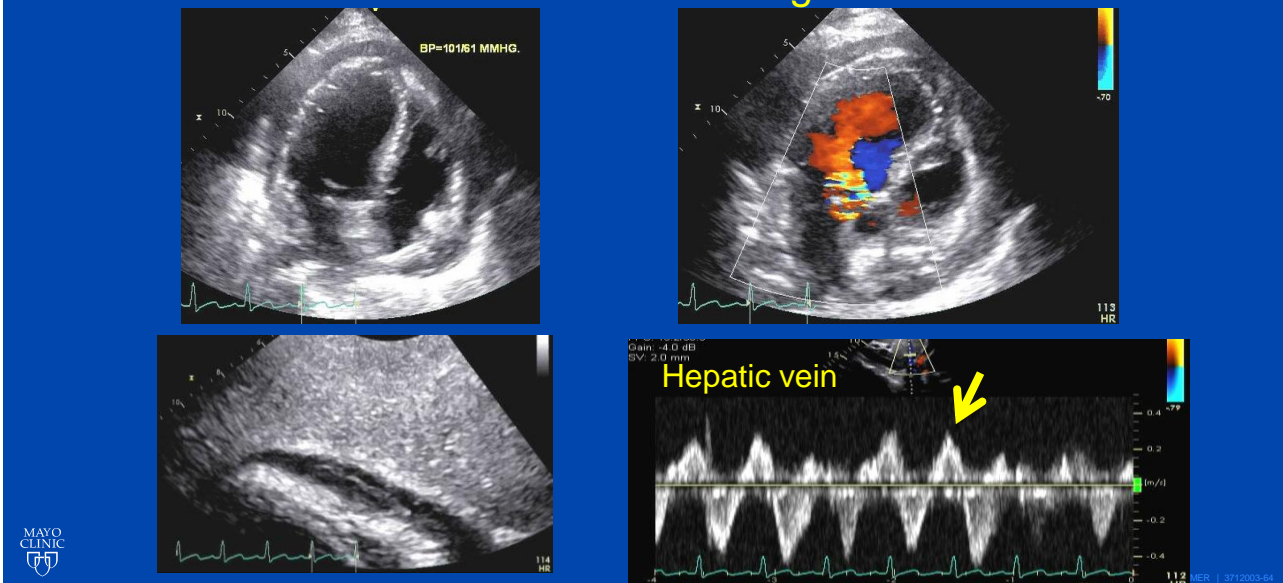


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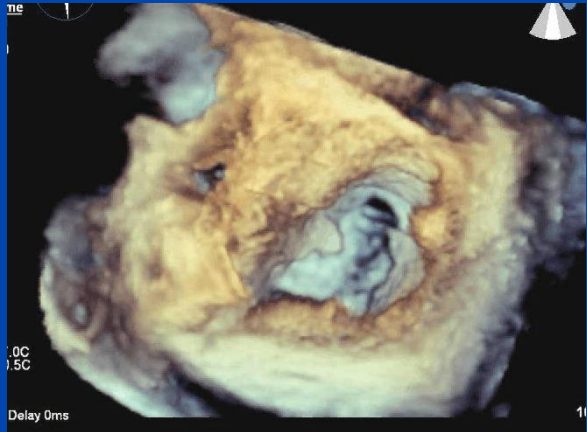
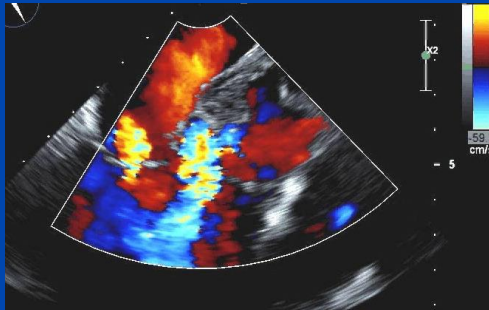
23 year old woman from Middle East with ascites several month after acute pericarditis and pericardial effusion (Thrombotic CP)



35 yo man presents with dyspnea and fever BP 80/40 mmHg



35 yo man with tamponade and fever TEE after pericardiocentesis

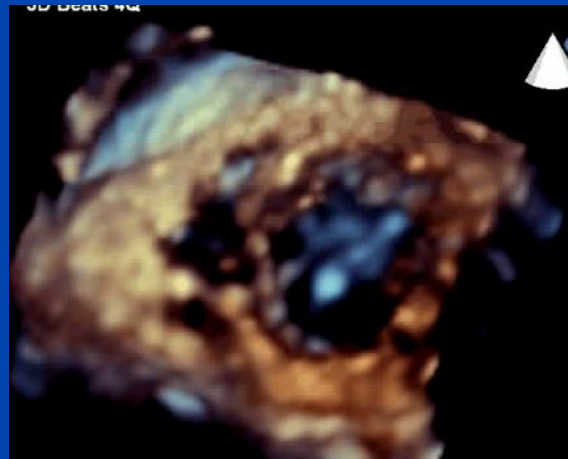
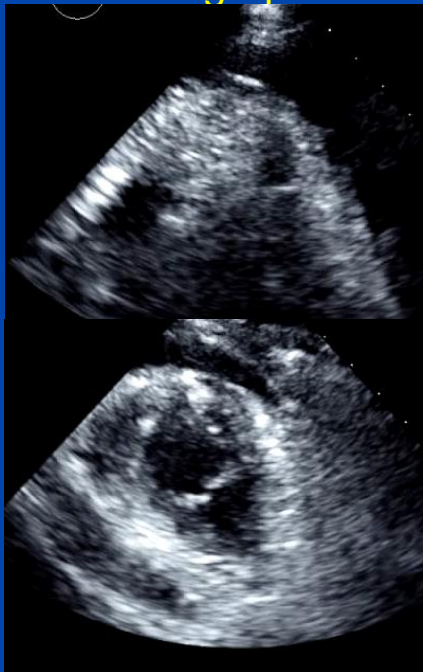


Final Pericardial Disease Case 45 yo male with chest pain x 4 days

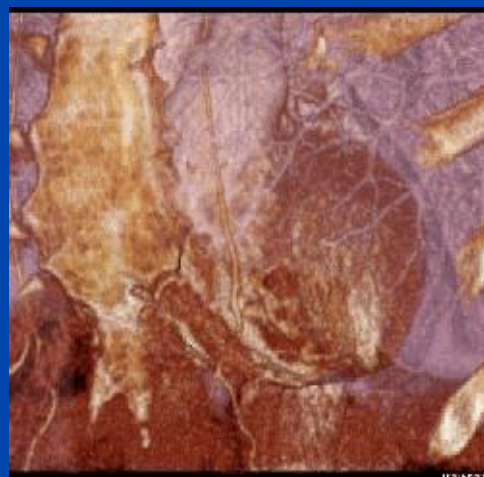
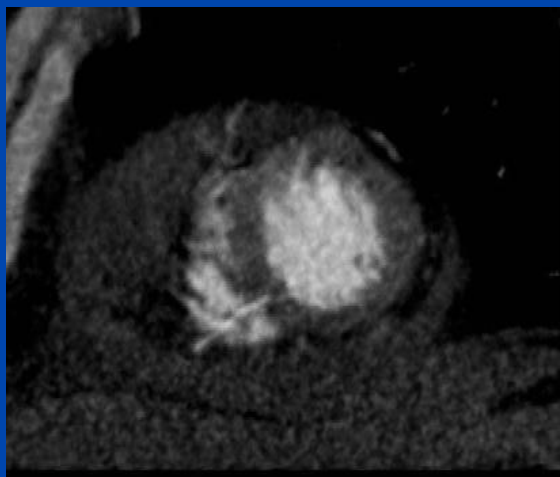
- Pain preceded by heavy lifting while camping. No relationship to exercise.
- MVA with pelvic and rib fractures. Chest tube and IVC filter placement 6 yrs ago.
- Many CV risk factors



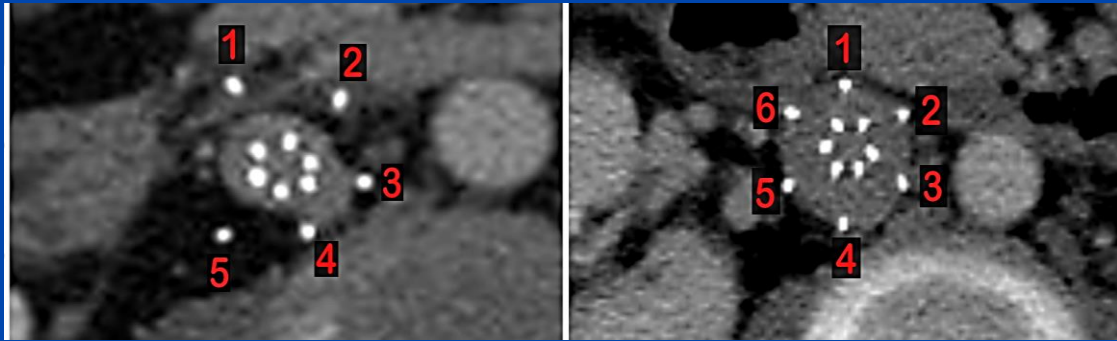
Echocardiographic images in 45 yo with chest pain



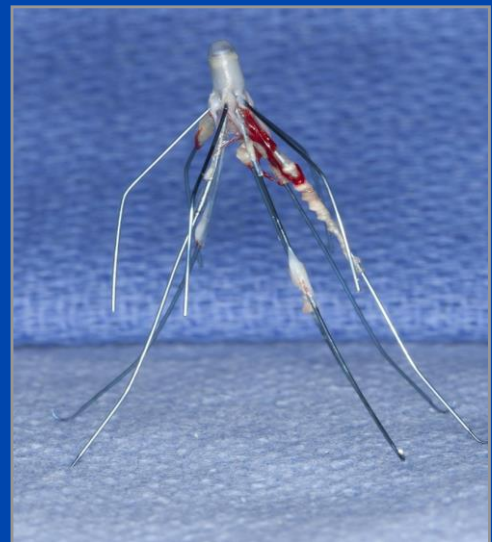
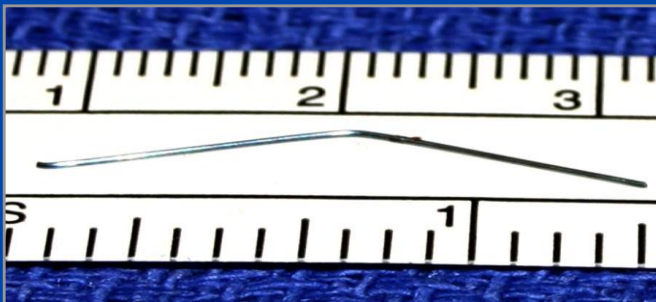
Chest and Cardiac CT



CT scans now and 8 years ago

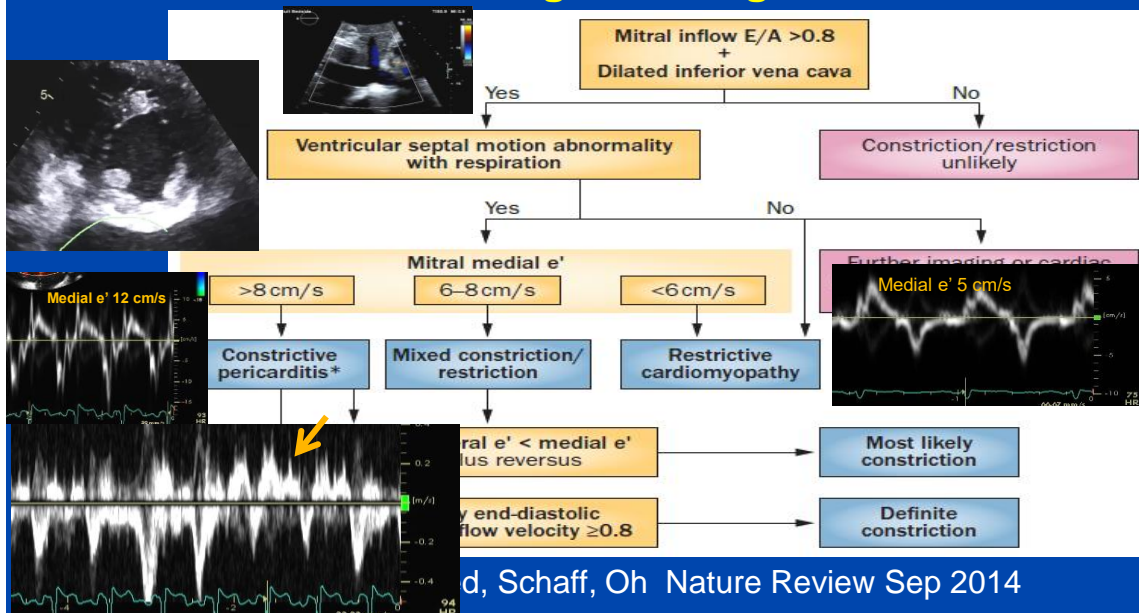


Embolic strut from IVC Filter





Constriction or Myocardial Disease ? Diagnostic Algorithm



d, Schaff, Oh Nature Review Sep 2014

Thank You !

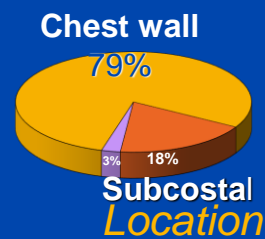
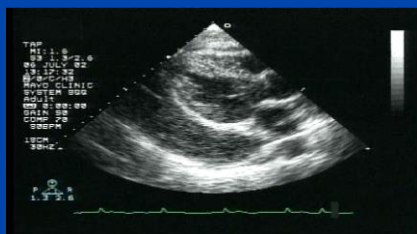
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Echo-Guided Pericardiocentesis



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Questions & Discussion

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